APPENDIX 10B

Structural Engineering Design Criteria

10B1 Introduction

Control of the design, engineering, procurement, and construction activities on the project will be completed in accordance with various predetermined standard practices and project specific practices. An orderly sequence of events for the implementation of the project is planned consisting of the following major activities:

- Conceptual design
- Licensing and permitting
- Detailed design
- Procurement
- Construction and construction management
- Startup, testing, and checkout
- Project completion

The purpose of this appendix is to summarize the codes and standards and standard design criteria and practices that will be used during the project. The general foundation and civil engineering design criteria defined herein form the basis of the design for the foundation and civil systems of the project. More specific design information will be developed during preliminary and detailed design to support equipment procurement and construction specifications. It is not the intent of this appendix to present the detailed design information for each component and system, but rather to summarize the codes, standards, and general criteria that will be used.

Section 10B2 summarizes the applicable codes, standards laws and ordinances and Section 10B3 includes the general criteria for foundations, design loads, and, general site information.

10B2 Design Codes, Standards, Laws and Ordinances

The design and specification of work will be in accordance with all applicable laws and regulations of the federal government, the State of California, and with the applicable local codes and ordinances. The following laws, ordinances, codes, and standards have been identified as applying to civil engineering design and construction.

The edition and/or addenda to a law, ordinance, code, or standard that has been adopted and is in place at time of plant design and construction will apply to work performed for this Facility.

A California Professional Engineer stamp is required on design documents.

10B2.1 State and Local Building Codes, Standards and Ordinances

- Code, Rules and Regulations of the State of California

- California Building Standards Code (CBSC)
- Uniform Building Code (UBC)
- California Electrical Code
- California OSHA (CALOSHA)
- Local ordinances, regulations, and requirements

10B2.2 U.S. Government Codes, Ordinances, and Standards

- Occupational Safety and Health Act (OSHA)—29 CFR 1910, 1926
- Federal Aviation Agency (FAA)—Obstruction Marking and Lighting AC No. 70/7460-IJ)
- Environmental Protection Agency (EPA)—40 CFR 423, 40 CFR 60, 40 CFR 72, 40 CFR 75, 40 CFR 112
- Appendix A to Part 36, "American Disability Act Accessibility Guidelines for Buildings and Facilities (applicable only to administrative and control room areas).

10B2.3 American National Standards Institute

The following standards of the American National Standards Institute (ANSI) will be followed:

- B16.1 Cast Iron Pipe Flanges and Flanged Fittings
- B16.5 Steel Pipe, Flanges, and Fittings
- B16.34 Steel Valves
- B30.17 Overhead and Gantry Cranes

If comparable international standards to ANSI standards are proposed by Contractor, the Contractor has full responsibility to confirm the international standards are equal or better than ANSI standards, and that the deliverables are acceptable per the codes, standards, and permits of the site.

10B2.4 Industry Standards

Applicable standards issued by the following industry organizations:

- American Association of State Highway and Transportation Officials (AASHTO)
- American Concrete Institute (ACI)
- American Gas Association (AGA)
- American Institute of Steel Construction (AISC)
- American Iron and Steel Institute (AISI)
- American Petroleum Institute (API)
- American Society for Nondestructive Testing (ASNT)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Crane Equipment Manufacturer's Association of America (CMMA)
- Metal Building Manufacturers Association (MBMA)
- National Association of Corrosion Engineers (NACE)

- Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- Steel Structures Painting Council (SSPC)
- Thermal Insulation Manufacturers Association (TIMA)
- Welding Research Council (WRC)

If comparable international standards to above U.S. industry standards are proposed by Contractor, the Contractor has full responsibility to confirm the international standards are equal or better than the U.S. industry standards, and that the deliverables are acceptable per the codes, standards, and permits of the site.

10B3 Structural Design Criteria

The following design criteria will govern the requirements regarding dead and live loads, other loads, and loading combinations in the design of structures. The loads specified herein are the minimum loads to be considered in the design.

Steel structures will be designed by either the working stress method (ASD) or load reduction factor method (LRFD).

Reinforced concrete structures will be designed by the ultimate strength method.

10B3.1 Site Conditions

The Project will be designed in accordance with the following Site Conditions:

10B3.1.1 Site Elevation and Barometric Pressure

Maximum 12.0 feet above mean lower low sea level, Site Mean Elevation

29.91 mmHg Site Standard Barometric Pressure at Site Mean Elevation

10B3.1.2 Temperatures

The outdoor operating temperature range for all equipment:

- 21 °F, Minimum Dry Bulb Temperature
- 87 °F, Maximum Dry Bulb Temperature

The Peak Summer Conditions (i.e., June through September), as determined by the average of the summer monthly maximum daily peak dry bulb temperatures and coincident relative humidity for 1995-2004:

- 67.5 °F, Dry Bulb Temperature, 61% Coincident Relative Humidity

10B3.1.3 Precipitation, Wind, Snow, and Earthquake

The Project will be designed for the maximum rainfall conditions listed below, in inches:

- 2.9 inches, 2-year, 24-hour maximum
- 4.25 inches, 10-year, 24-hour maximum
- 4.9 inches, 25-year, 24-hour maximum
- 5.4 inches, 50-year, 24-hour maximum
- 6.02 inches, 100-year, 24-hour maximum

Design snow loads will be in accordance with the requirements set forth in the latest editions of the California Building Standards Code (CBSC), and local governing building code. Design wind loads will be in accordance with the requirements set forth in the CBSC, and local governing building code.

The applicable basic wind velocity site specific exposure is 80 miles per hour, Design Wind Velocity at a point 33 feet above ground level.

All structures shall be designed for wind loading/pressures based on the following minimum design parameters in accordance with the California Building Standards Code

Exposure Type: D

Importance Factor (I_w) = 1.0

Seismic design loads will be in accordance with the requirements set forth in the CBSC, and local governing building code. The applicable seismic zone is Zone 4 with near fault effects. The site will be assigned a soil profile type as substantiated by geotechnical data for the specific site. The applicable seismic zone and minimum parameters are:

- Seismic Zone 4
- Seismic Zone Factor = 0.40
- Importance Factor, IP = 1.00

The HBRP site is on the shoreline of Humboldt Bay and directly opposite the mouth of Humboldt Bay and is subject to tsunami inundation Accordingly, the HBRP design will be to anchor all structures, including the diesel fuel tank(s) to prevent flotation, collapse or lateral movement resulting from hydrodynamic and hydrostatic loads, including buoyancy.

10B3.2 Design Loads, Load Combinations and Allowable Stresses

10B3.2.1 Dead Loads

Dead loads will be considered as the weight of all permanent construction, including walls, floors, ceilings, stairways, all fixed empty vessels and equipment, built-in partitions, structures, fireproofing, insulation, piping, and electrical conduits.

10B3.2.2 Live Loads

Live loads will be defined as those loads produced by the use and occupancy of the buildings or other structures and do not include environmental loads such as wind load, snow load, rain load, earthquake load, or dead load. Live loads on a roof are those produced (1) during maintenance by workers, equipment, and materials and (2) during the life of the structure by movable objects. Live loads will be uniformly distributed over the horizontal projection of the specified areas and will have the minimum values noted below.

10B3.2.2.1 Platforms, Walkways, and Stairs

A uniform live load of 100 pounds per square foot (psf) will be used. In addition, a concentrated load of 2 kips will be applied concurrently to the supporting beams to maximize stresses in the members, but the reactions from the concentrated loads will not be carried to the columns.

A uniform load of 50 psf will be used to account for piping and cable trays where applicable. Where the piping and cable tray loads exceed 50 psf, the actual loads will be used.

10B3.2.2.2 Pipe Racks

A minimum uniform load of 100 psf will be used for each level of the pipe racks. Where the piping and cable tray loads exceed 100 psf, the actual loads will be used. In addition, a concentrated load of 5 kips will be applied concurrently to the supporting beams to maximize stresses in the members, but the reactions from the concentrated loads will not be carried to columns.

Hangers for piping and equipment loadings, anchor forces, and other restraining forces will be determined by engineering analysis. In areas where numerous miscellaneous small bore piping, conduit, and cable tray loads will exist, an additional uniform load to be determined by the structural engineer will be added to the design loads.

10B3.2.2.3 Ground Floor (Slab at Grade)

Design will be based on equipment weight, storage, or laydown weight or a uniform load of 250 psf, whichever is greater.

10B3.2.2.4 Thermal Forces

Thermal forces caused by thermal expansion of equipment and piping under all operating conditions will be considered.

When portions of a structure are not free to expand or contract under temperature variations, allowance will be made for stresses resulting from temperature change. When portions of a structure are subject to unequal temperature variations, allowance will be made for stresses resulting from the variation.

10B3.2.2.5 Dynamic loads

Dynamic loads will be considered and applied in accordance with Applicable Standards.

Vibration load will be defined as those forces that are caused by vibrating machinery such as pumps, blowers, fans and compressors, engines and generators.

All supports and foundations for vibrating equipment will be designed to dampen vibrations and as required by the equipment manufacturers. Allowance will be made for such dynamic effects, including impact, by increasing the computed live load value by an adequate percentage.

For structures supporting elevators, machinery or craneways, design for impact will be as required by ASCE 7-95.

10B3.2.2.6 Truck Loads

Roads, pavements, underground piping, conduits, sumps, and foundations subject to truck traffic will be designed for HS-20-44 loadings in accordance with AASHTO Standard Specifications.

A surcharge load of 250 psf will be applied to the Project structures where accessible to truck traffic.

10B3.2.2.7 Wind Loads

All structures will be designed for a basic wind velocity in accordance with the requirements of the State of California Building Standards Code as listed in 3.1.3 above.

10B3.2.2.8 Seismic Loads

Structures will be seismically designed in accordance with the requirements of the State of California Building Standards Code.

10B3.2.2.9 Other Loads

Other loads used to predict the structural response of structures will include hypothetical loads representing the influence of piping, including water hammer, and loads at anchor points and electrical installations not included in the normal dead or live loads. Pressure or suction loads such as encountered in ductwork will be taken into account, including dynamic loads from operating equipment.

Earth pressures will be defined as the active and passive lateral forces associated with soil and hydrostatic pressures.

Handrails/guardrails for stairs, platforms, or other uses will be designed to withstand a lateral load of 20 pounds per linear foot (plf) or 200 pounds applied in any direction at any point on the top of the rail.

10B3.2.2.10 Allowable Stresses

- Concrete: In accordance with ACI 318 Code
- Masonry: In accordance with the California State Building Standards Code

10B3.2.2.11 Load Combinations

Appropriate loading combinations will be used for structural steel and reinforced concrete to comply with applicable codes and standards and with vendor requirements.

10B3.2.2.12 Factor of Safety

Minimum factors of safety for all structures, tanks, and equipment supports will be as shown below:

- Overturning 1.50
- Sliding 1.10 for seismic load
  1.50 for wind load
- Buoyancy 1.25
- Uplift due to wind 1.50

10B3.3 Architectural

All buildings will be weather tight with insulated metal siding and standing-seam roofing.

Buildings will have insulated walls, roof, and ceilings designed to complement the specific building area use and optimize HVAC system design. For example, air conditioned areas will use wallboard and non-air conditioned areas will use 26 gauge steel liner panels.

The outside of the exterior building panels will have a baked-on Kynar 500, or equivalent, coating system having a minimum of 70% Kynar resin. Wall insulation will use a minimum

R-13 fiberglass blanket insulation with UL 25 vapor retardant. The wall panel thickness will be as required to provide an insulated wall heat transmission coefficient "U" per ASTM C236 not greater than 0.10 Btu/hr-ft^2-°F. The pre-fabricated modular equipment enclosures will have the supplier's standard industrial finish. All exterior doors will have weather protection awnings or vestibules.

Roof slopes will be within the range of 0.5 to 1 inch of rise per 12 inches of run. The outside of the exterior panel will have a baked-on Kynar 500, or equivalent, coating system having a minimum of 70% Kynar resin. Minimum R-19 fiberglass blanket insulation with UL 25 vapor retardant will be used and attached to the ceiling with metal components such that there is no sagging. Roof panel thickness and width will be as required to provide a "U" factor of 0.08 or less and gauge and shape of panels will be sufficient to withstand all design loadings without excessive deflection or vibration.

All buildings will be provided with gutters and downspouts, routed to the storm drain systems.

Suspended lay-in acoustical tile ceilings, vinyl composition floor tile with resilient base, and recessed fluorescent lighting will be provided in offices, restrooms, lunch room, conference room, storage areas, electronics room, and the control room. Partitions in the administration area will consist of painted gypsum board on each side of 3-5/8" metal studs. A folding partition will be installed in the lunchroom. High-bay buildings such as the power house and maintenance area will have high-pressure sodium vapor lighting.

For high-moisture areas, such as showers and locker rooms, ceilings will have moisture resistant, lay-in tiles. Unglazed ceramic tile will be used on floors in high moisture areas such as locker rooms, showers, and toilets.

Steel-troweled, surface-hardened concrete will be used in unfinished areas. Any chemical containment areas will be of concrete construction and use barrier coatings or linings as required for the chemical environment.

All wall surfaces, ceilings, doors, and frames will be painted. The color scheme for the project will be selected by the Owner from color samples submitted by the Contractor.

Windows will be manufacturer-standard aluminum, factory tinted, used in commercial or industrial applications, as appropriate.

Double doors with transoms will be provided where required for equipment removal and access.

Doors will meet the requirements of Steel Door Institute-recommended specifications 100-91, Grade II, Model 2. Doors will be heavy-duty seamless-composite construction using 18 gauge galvanized face sheets. Door frames will be formed of 16 gauge steel to the sizes and shapes required. Doors for the pre-fabricated modular equipment enclosures will be the supplier's standard for industrial applications.

Doors and frames in the outer limits of environmentally controlled areas will be fully insulated. Where fire doors are required, the door, frame, and hardware will bear a certification label from Underwriter's Laboratories for the class of opening and rating.

Doors will be finished with glass and glazing at the following locations: building entries and exits, control room, laboratory, hallways, offices, and any other high traffic areas where viewing windows will help prevent the doors from being opened into oncoming traffic. Glass and glazing will conform to the requirements for glazing materials for Category II products in accordance with the Safety Standards for Architectural Glazing Materials 16 CFR 1201, and installed in accordance with the publications of the Flat Glass Marketing Association.

The Contractor will provide locks on each door and 10 sets of a coordinated master key set for all lockable panels, hatches, covers, doors, etc.

Rolling steel doors will be interlocking galvanized steel slats to withstand a wind pressure of 25 pounds per square foot. Doors will be motor operated with manual override and three push-button controls.

The personnel access way to and from buildings will be provided with canopies or substantial overhangs to protect personnel from foul weather while entering and leaving the buildings.

Fire-rated assemblies will be provided when required by building or fire codes. Penetrations through partitions will be provided with fire stops. Insulation will be used for sound and thermal control in walls between and around finished rooms and air-conditioned areas.

The Contractor will supply all fixtures and appliances for the control/maintenance building. Contractor will provide commercial-grade carpeting in offices, conference room, file room, and lunch room. The carpet style and color scheme for the project will be selected by the Owner from samples submitted by the Contractor.

Piping and electrical conduit and equipment along the walls within the maintenance area will be located to maximize the amount of space available for shelving.

10B3.3.1 Building Systems

The Project will include ventilation and air conditioning for each building. All HVAC and ventilation systems throughout the plant will be sized and installed appropriately for climate and dust control as defined in other sections.

10B3.4 Foundations for Equipment and Structures

All equipment foundations and concrete structures will be designed and built per manufacturers' criteria, the soil investigation, and the geotechnical report.

Soil stabilization, remediation, piles, etc. will be provided as required for all plant facilities including buried lines and facilities as required by the geotechnical investigation report.

Foundation analysis and design will be performed for the engine and generator as recommended by the respective equipment manufacturers. All foundations designed for rotating equipment will be adequate, and will not be subject to failure due to induced vibration. In addition, foundations for rotating equipment will not result in unreasonable vibration levels, consistent with Prudent Utility Practices or violate OEM guidelines.

Foundation analysis for major equipment will include the evaluation of total and differential settlement. At grade, outdoor tank foundations may be ring-type or reinforced concrete mat design. Tanks, equipment skids, pumps, and supports will be installed on raised slabs or pads for corrosion protection.

Dynamic foundation analysis will be performed for the engine generators. The design will ensure that all foundations for rotating equipment are adequate and will not be subject to failure due to induced vibrations. In addition, foundations for rotating equipment will not impart unreasonable vibration levels, consistent with normal utility industry practice, as well as OEM guidelines and specifications, to surrounding foundations and equipment.

Grade-floor elevations of buildings and the tops of foundations for major outdoor equipment at grade will be at a minimum 6 inches above the high point of the finished grade elevation. All concrete will be designed per applicable American Concrete Institute (ACI) standards.

Oil-filled transformer foundations will have an integral reinforced concrete spill containment area. Ground wires will be embedded in foundations and stubbed up at their final location to prevent a tripping hazard.

10B3.5 Concrete Work

Concrete design will be in accordance with the latest release of ACI codes 318, and 350.

Concrete design for the cooling tower basin, if required, will be appropriate for the design water chemistry inside the basin.

Exposed concrete floors within the administration, control, warehouse, maintenance, water treatment, chemical feed, and unloading areas are to have a brushed finish and be sealed to impart chemical resistance where such exposure is possible.

Duct banks that run under roads and maintenance areas will be adequately reinforced to withstand anticipated loads.

10B3.6 Masonry Work

Structural masonry will be designed in accordance with ACI - 530, “Building Code Requirements for Masonry Structures.”

10B3.7 Steel Work

The steel structure to be used for pipe racks, the power house, and warehouse/maintenance shop will be designed, fabricated, and erected in accordance with American Institute of Steel Construction specification.

Bolts and nuts for galvanized structural steel will be mechanically galvanized. or hot dipped galvanized.

All materials will be free of imperfections. Rolled structural steel wide flange shapes will confirm to ASTM A992. All other structural steel shapes, bars, and plates will confirm to ASTM A572, Grade 50, unless otherwise noted on the design drawings. Steel pipe and handrails, guardrails and posts will confirm to ASTM A53, Grade B Type E or S. Handrails,

guardrails and posts will be 1-1/2 inch nominal inside diameter standard weight pipe. Rectangular, square and round hollow structural sections (HSS) will confirm to ASTM A500 and/or ASTM A501.

All hoist and monorail support beams will be clearly marked with their rated capacity.

10B3.7.1 Steel Grating and Steel Grating Stair Treads

The steel to be used for grating and grating treads will conform to ASTM A1011, commercial steel (CS, Type B). The ITW Ramset/Red Head Grating Disk system, or equivalent, will be used for fastening. Stair treads will be provided with nonslip abrasive nosings. The treads will have end plates for attaching to stringers. Grating will be of the rectangular type and consist of welded steel construction. Grating will be hot dip galvanized after fabrication in accordance with ASTM A 123. Outdoor grating will have a serrated surface. Grating will have at least a 1-inch bearing support and be designed for a minimum live load of 100 psf. Deflection will be limited to 1/200 of the span.

Floor or platform openings around the engines, pressure vessels, piping, and equipment subject to expansion will be protected as follows:

- Openings around penetrating objects exceeding 1.5 inches in width will be protected by toe plates
- Openings around penetrating objects exceeding 8 inches in width will be protected by toe plates and handrails

Cutouts required for any type of penetration, including those to be made in the field, will be provided in the floor grating. Cutouts smaller than 6 inches will be banded with bars as thick as the bearing bars. Cutouts 6 inches and larger will be banded with a 0.25-inch-thick toe plate projecting 4 inches above the finished floor.

Additional support members for the larger opening will be provided as required.

The direction of bearing bars will be consistent within the floor framing system, and they will be aligned with the adjoining section.

At the joints, the end of one section will be banded to prevent other sections from telescoping.

Surfaces on which the galvanized finish has been damaged, scratched, or defaced before acceptance will be cleaned and touched up with galvanized repair paint in accordance with the paint manufacturer's instructions.

10B3.7.2 Stairs and Ladders

Stairs will be provided for the purposes of traveling from one elevation to another. Vertical ladders may be provided only where personnel access is infrequent. Safety cages and/or other devices will be provided for fixed ladders per OSHA, and will have landings no further than every 30 feet. Safety cages and ladder openings will include self-closing gates.

10B3.8 Design

The design will conform to Applicable Laws and Applicable Standards. The design will be based on the CBSC, and other applicable local or state building code, the American Concrete Institute (ACI), and American Institute of Steel Construction (AISC). All buildings, structures and equipment will be designed and built in accordance with Applicable Laws and Applicable Standards.

Strength design will generally be employed for reinforced concrete structures, and allowable stress design or load and resistance factor design employed for steelwork.

Wind, snow, and earthquake loading will be in accordance with Applicable Laws and Applicable Standards.

The design will take account of all applied loads, including dead, live, impact, thermal, dynamic, settlement, movement, and seismic, and other loading conditions where appropriate. Temporary loads during maintenance and erection will be considered.

Platforms will be designed for a minimum live load of 100 psf. Platform design will employ the use of grating in lieu of checkered plate unless required for containment purposes. All handrail, toe plate, ladders, cages, gates, etc., will be in accordance with OSHA Standard Rules and Regulations.

Pre-engineered building rafters will be designed for the appropriate collateral loading from roof supports, HVAC ducts, cable tray, and piping.

Grade slabs (engine equipment laydown) will be designed, at a minimum, for 300 psf. Ground floor slabs for shops and auxiliary buildings will be designed, at a minimum, for 150 psf. Storage areas will be designed for actual weight of material but no less than 150 psf.

Vendor-generated structural steel details, concrete reinforcing details, and erection drawings are to be reviewed and approved by the Contractor's Professional Engineer, registered in the state where the Project is located.

Access doors and hand rails will be designed and located for easy access for maintenance and inspections. Adequate hand railing and fall protection barriers will be installed for maintenance activities.

10B3.9 Construction

Working methods will ensure the construction of stable structures able to withstand all applied loadings during construction and for the design life of the Project without collapse, failure, or excessive deformation such as to cause any damage, loss of function, or durability problems.

A permanent Project benchmark will be established on the Project site by the Contractor based upon USGS vertical datum. Settlement monitoring points will be provided, with a minimum of four points for each end of the bank of engines. The existing elevation at each point will be inscribed on an embedded brass marker before setting of equipment.

All welding will be performed by welders qualified in accordance with AWS D1.1, using only procedures qualified in accordance with AWS D1.1.

10B3.10 Testing and Inspections

A program for testing soils during earthwork and when underground utilities and foundations are installed will be utilized.

The minimum moisture and density testing requirements for structural fill will be one test per 75 cubic yards with at least one test under each foundation greater than 15 square feet.

In-place representative field density tests will be performed in accordance with ASTM D 1557.

If a compacted area fails to meet the specified compaction requirements, two additional tests will be performed for that area. If the results of either of the two additional tests-prove unsatisfactory, the area will undergo additional compaction and testing until test results meet the minimum compaction requirements.

Records of inspection and testing of soils to ensure compliance with design assumptions will be turned over to Owner and will comply with Applicable Standards. If pile-supported foundations are to be used, the Contractor will conduct a pile load test program.

Testing and inspections of structures will be in accordance with Applicable Standards.

Concrete test cylinder sets will be taken at the minimum rate of one set per day but not less than once for each 150 cubic yards for slabs, foundations, or walls. Concrete test cylinder sets for paving will be taken at the minimum rate of 1 set per day but not less than once for each 150 cubic yards, nor less than once for every 5,000 square feet. As a minimum, one set of cylinders will be taken for each equipment foundation, with exception that one set of cylinders may be made for each concrete truck load where multiple small foundations are poured from a single load. Test procedures will be in accordance with the appropriate ASTM standards. Copies of test data will be provided to the Owner.

The Contractor will utilize a system to validate type and grade of high-strength bolts by sampling and metallurgical testing.

A testing program of high-strength bolts and nuts will be conducted by the Contractor to ensure that each bolt shipment meets the appropriate ASTM standards for dimensional tolerances and material quality.

All structural welds will be subject to inspection in accordance with weld quality requirements provided in AWS D1.1. Critical welds will be inspected as required, and all other welds will be subject to random inspection.